

MOISTURE RESTORATION FOR SEED COTTON, TWO APPROACHES

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Abstract

Research results over the years have shown that fiber quality is improved when lint moisture content at the gin stand is in the range 6 to 7 percent wet basis compared to lower levels. Under many conditions lint is drier than that when it arrives at the gin. This research added moisture to seed cotton in two ways before it was ginned. Then the fiber properties were examined by AFIS testing after ginning. The fiber length properties were highly correlated with the lint moisture content behind the gin stand and were less significantly or not significantly correlated with the method of attaining the lint moisture content. The other AFIS fiber properties related to trash, maturity, and neps were not significantly affected by the method of attaining the lint moisture level and nearly all of the other AFIS properties were not significantly affected by the moisture level of the fiber.

Introduction

The moisture content (mc) of the lint portion of seed cotton substantially affects its ability to withstand the forces of ginning and also affects the ease with which trash is removed from the seed cotton (Anthony, 1990). Cotton gins use drying systems to reduce the seed cotton mc before cleaning and ginning. In general, drier seed cotton is easier to clean; however, drier cotton lint is more susceptible to damage during ginning and cleaning (Hughes, Mangialardi, and Jackson; 1994). The damage is revealed by higher short fiber content and more fiber neps. The overall quality of fiber produced by gins would be improved if the moisture control system were able to add moisture to the lint as well as take it out. The optimum mc for fiber seed separation is 6.5 to 8 percent wet basis (Griffin, 1977) or even higher (Moore and Griffin, 1964); however due to the reduced cleaning efficiency the optimum mc for ginning is considered to be in the range from 6-7 percent wet basis (Hughes, Mangialardi, and Jackson; 1994).

The ideal moisture control system would be able to monitor the lint mc and dry the lint if needed, leave the lint mc unchanged if it came to the gin in the optimal range, and add moisture to the lint if it came to the gin drier than optimal. The process of adding moisture in the gin is called "moisture restoration" and is described and supported in both the 1977 and 1994 Cotton Ginners Handbook. Most current mc control systems are capable of only drying lint that comes to the gin at higher than optimal mc.

The purpose of this work was to use two different equipment designs to determine if significant differences in fiber properties result after ginning and lint cleaning by conditioning the seed cotton with moist air in what is normally the stage two drying equipment or by using conditioning hoppers above the gin stand.

Methodology

The first equipment design used a commercially available device, a Samuel Jackson Humidaire unit, which was reconfigured so that it would produce either warm dry air for drying, or warm moist air for moisture restoration. The air from the Humidaire unit was used to pick up the cotton after the stick machine, following the first tower drier, after which it went through a tower drier and was separated from the seed cotton in a cylinder cleaner.

A thermocouple-based temperature indicator was installed at the exhaust of the cylinder cleaner after the second tower drier to better monitor conditions. Control of the air temperature produced by the moisture-conditioning unit was based on a thermocouple located in the duct ahead of the air-cotton mix point under the stick machine. Control of the stage one drying was based on a thermocouple located in the top of the tower drier.

The second equipment design used an additional Humidaire unit to add moisture to the seed cotton in a hopper immediately above the gin stand. The hopper, manufactured by Samuel Jackson, had ducts for moist air application from both sides. The ducts each had a valve controlled by the gin stand so that moist air would not be applied when the gin stand breast was not "in."

The three treatments were 1) using heated air in the stage two drying system and no air with the hopper, 2) using humidified air in the stage two drying system and no air with the hopper, 3) using heated air in the stage two drying system and humidified air in the hopper. The stage 1 drying air control was set to 200°F at all times. When the heated air was used in the stage two drier the temperature setting was 120°F. When humid air was used in the stage two drier the water temperature was 104°F and the air temperature setting was 110°F. The water temperature setting was 112°F and the air temperature

setting was 120°F for the air for the hopper above the gin stand. The humidifier settings were lower than normally used in conditioning lint and the resulting air carried much less moisture than could be carried with higher settings. The treatments were meant to produce different lint mc levels but not to necessarily achieve a certain final mc.

Seed cotton samples were taken at the feed control. Lint samples were taken between the gin stand and the lint cleaner and also at the lint slide for determination of mc and fiber quality. The mc of the lint samples taken at the two locations were determined by the oven method (Shepherd, 1972). After conditioning the fiber samples using standard temperature and relative humidity conditions fiber quality was measured by Advanced Fiber Information System (AFIS), which measures fiber maturity, fiber trash, neps, and fiber length. The data were analyzed with the procedures MEAN, MIXED, and GLM from SAS (1999).

The ginning tests were performed on Aug. 29 and 30, 2002 at the U.S. Cotton Ginning Laboratory in Stoneville, MS. The standard seed cotton cleaning of one cylinder cleaner followed by a stick machine was used after the first stage of drying, and an additional cylinder cleaner was used after the second stage drier. A Continental model 93 Double Eagle gin stand was used for ginning and two stages of saw-type lint cleaning were used. The seed cotton was Stoneville 4892BR, grown at Stoneville MS, and harvested between Oct. 11 and Oct. 17, 2000. The average ambient temperature during the ginning was 86°F and the average relative humidity was 60%.

Results

Five seed cotton samples per bale were taken from the feed control and from under the stick machine and analyzed for mc. These data were tabulated, Table 1. The mc data in table 1 was from the analysis of seed cotton samples; the other data in this report resulted from measurement of lint mc and cannot be compared easily with seed cotton mc. The seed cotton mc varied somewhat from one test bale to another but that for most of the bales the standard deviation was 0.47 or below for all bales except 2, 5, and 7. Ten samples were taken for each bale behind the gin stand. The mc mean and standard deviation of these samples were tabulated, Table 2. Table 2 also shows the treatment for each bale. The standard deviations show that the lint mc values were more stable for each bale than the seed cotton mc readings. The standard deviations for bales 7 and 8 appear to be higher than the others. Statistical analysis showed that although the mc levels for the samples conditioned through the hopper over the gin stand were not much higher than the samples with no moisture addition, both moisture addition treatments added a measurable and statistically significant amount to the mc. The study was not designed to determine which method could add more moisture to the lint and Table 2 data should not be used in this way.

The AFIS data were analyzed using SAS procedure GLM. Tables 3, 4, and 5 present the statistical significance of the factors tabulated. Columns are specified for the samples collected ahead and after the lint cleaners. Within those columns there are columns for effects due to the amount of moisture in the lint and the method of obtaining the mc level (the three treatments). The effect of factors such as the date of ginning and the bale were not significant. For most of the data, the moisture restoration method was not significant. The results of the analysis on the nep data were summarized in Table 3. The only factor which was significant was the moisture effect on the mean nep size. This factor was significant for the samples taken ahead of the lint cleaners as well as behind. The change in the mean size of the neps was -21.5 and -24.9 for the samples collected ahead and behind the lint cleaners respectively. This means that if the mc was increased, the data showed that the nep size would decrease. The AFIS data for the trash measurements, Table 4, did not result in any significant changes related to the lint mc or the treatment. There were no significant variations in the AFIS maturity data, Table 4.

The results of the AFIS length data analyses are summarized in Table 5. Most of the factors were affected significantly by the mc of the lint. The fiber length mean by weight was significantly affected in the samples ahead and behind the lint cleaners. The data showed that in this mc range an increase on 1% in mc would result in an increase of 0.03 inches in fiber length. Similarly an increase of 1% in mc would result in a decrease of 0.8 and 1.2 in the coefficient of variation in length for samples ahead and behind the lint cleaners, respectively. The short fiber content, by weight, would decrease by 0.9 and 1.1 percent for samples collected ahead and behind the lint cleaners respectively, for an increase of mc of 1%. Comparing the significance of the mc of the lint to the treatment, in nearly all cases the treatment was less significant than the mc of the sample. This means that for this data it did not matter how the moisture got into the fiber, only how much moisture was in the fiber. Even for the samples with no moisture addition the mc of the fiber was highly significant in affecting the AFIS length parameters.

Conclusions

Three moisture treatments were used on seed cotton. The cotton was ginned, lint samples were collected for analysis by AFIS testing. The statistical analysis showed that the fiber length properties were highly correlated with the mc of the lint behind the gin stand, even for samples with no moisture addition. In every case the fiber length properties were improved with increased mc. The treatment method had a less significant or insignificant affect. The other AFIS properties related to trash levels, neps and maturity were not significantly affected by the treatments.

Disclaimer

Mention of a trade name, proprietary product, or specific equipment does not constitute a guarantee or warranty by the U. S. Department of Agriculture and does not imply approval of the product to the exclusion of others that may be available.

References

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Table 1. Seed cotton moisture content by bale for the test before first stage and second stage drier.

Bale	Moisture content entering gin		Moisture content after first stage drier
	Mean	Std. Deviation	Mean
1	8.9	0.32	7.7
2	8.6	0.87	8.0
3	8.8	0.10	7.6
4	9.5	0.40	7.6
5	9.3	0.73	7.2
6	8.9	0.16	7.8
7	8.7	0.88	7.5
8	9.7	0.33	7.5
9	9.5	0.27	8.0
10	9.8	0.33	8.5
11	10.5	0.35	8.2
12	10.0	0.25	9.0
13	10.0	0.47	8.6
14	10.1	0.37	8.8
15	10.1	0.21	8.7

Table 2. Experimental treatment and lint moisture content of samples taken between the gin stand and the lint cleaners.

Bale	Moisture addition	Moisture content behind the gin stand	
		Mean	Std. Deviation
1	Second tower	5.2	0.09
2	Second tower	5.2	0.17
3	Above gin stand	5.0	0.16
4	Above gin stand	5.0	0.15
5	None	4.7	0.09
6	None	4.7	0.12
7	Above gin stand	4.9	0.30
8	Second tower	5.0	0.30
9	Second tower	5.0	0.06
10	Above gin stand	4.9	0.15
11	Above gin stand	4.9	0.13
12	Second tower	5.8	0.16
13	Second tower	5.7	0.18
14	None	5.0	0.14
15	None	5.2	0.15

Table 3. Statistical significance levels from analysis of AFIS nep data for samples taken at two locations.

Variables	Ahead of lint cleaners		After lint cleaners	
	Moisture	Treatment	Moisture	Treatment
Neps (count per g.)	0.63ns	0.55ns	0.41ns	0.10ns
Nep (mean size)	0.03*	0.97ns	0.03*	0.73ns
Seedcoat nep (count per g.)	0.06ns	0.46ns	0.20ns	0.95ns
Seedcoat nep (mean size)	0.34ns	0.46ns	0.11ns	0.17ns

ns – not statistically significant

* - statistically significant at the 0.05 level

Table 4. Statistical significance levels from analysis of AFIS trash and maturity data for samples taken at two locations.

Variables	Ahead of lint cleaners		After lint cleaners	
	Moisture	Treatment	Moisture	Treatment
Total trash (count per g.)	0.85ns	0.34ns	0.81ns	0.99ns
Trash (count per g.)	0.66ns	0.14ns	0.42ns	0.23ns
Dust (count per g.)	0.88ns	0.37ns	0.89ns	0.99ns
Mean trash size	0.61ns	0.15ns	0.61ns	0.15ns
Visible foreign matter	0.42ns	0.20ns	0.70ns	0.62ns
Fineness	0.92ns	0.75ns	0.33ns	0.16ns
Immature fiber content	0.95ns	0.37ns	0.39ns	0.29ns
Maturity ratio	0.97ns	0.66ns	0.25ns	0.14ns

ns – not statistically significant at the 0.05 level

Table 5. Statistical significance levels from analysis of AFIS length data for samples taken at two locations.

Variables	Ahead of lint cleaners		After lint cleaners	
	Moisture	Treatment	Moisture	Treatment
Length, mean by weight, (in.)	0.0004**	0.038*	0.0001**	0.003**
Length, mean by weight Coefficient of variation	0.031*	0.33ns	0.0001**	0.64ns
Upper quartile length, by weight (in.)	0.008**	0.034*	0.009**	0.005**
Short fiber content, by weight. (percent)	0.003**	0.21ns	0.0001**	0.002**
Length, mean by number, in.	0.0004**	0.059ns	0.0001**	0.004**
Length, mean by number Coefficient of variation	0.055ns	0.28ns	0.002**	0.27ns
Short fiber content, by number, (percent)	0.008**	0.30ns	0.0001**	0.028*
Length, 5% level, calculated by number (in)	0.014*	0.019*	0.003**	0.003**
Length, 2.5% level, calculated by number (in)	0.011*	0.045*	0.004**	0.022*

ns – not statistically significant

* - statistically significant at the 0.05 level

** - statistically significant at the 0.01 level